News for the Curious;

A

TREATISE

OF

Telescopes,

OR,

An Account of the Marvelous Astronomical Discoveries of late years made throughout *Europe* by the help of Telescop
the Figures.

ALSO

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M. Pardo at the *Black*
Downes at the *Three Fl*
and *B. Aylmer* at the 7
Exchange. 1684.

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TO THE

HONOURABLE

Sir *William Portman* Baronet,

And Knight of the *Bath*.

IT may truly be affirm'd that Nature made an equal Partition of all her Goods amongst her Children, the Eagle and Hawk for Sight, the Hound for Sent, the Lilly and Peacock for gay Cloathing;

Birds, Beaſts, and Fiſhes went away alike ſatisfi'd and pleas'd with their State and Condition. Man in this Diſtribution (whilſt he retain'd his Innocency) was Gods Vicegerent upon Earth, and beſides the Enjoyment of the World, and the Command of all Creatures, he had alſo Fellowſhip with Angels; but failing of his Allegiance, he was ſoon degraded of his Dignity, and became ſubject unto manifold Miſeries, and even to Death it ſelf; yet in his fallen Eſtate there is to be ſeen ſome Marks of his Divine Original. The Heathen Poet ſings of him, *Os hominì ſublime dedit Cœlumque*

que tueri. That he is not a Child of Earth like other Creatures, but chiefly made to Contemplate Heavenly things; of an erect Countenance, fitly fram'd with two Eyes, wonderfully made to view the Works of God's Hands. It is true, the Natural Imbecillity, as of others, ſo of our Viſive Organs, doth not permit us to take ſo full a view as we could wiſh of Bodies that are always at great diſtances, therefore Men by their Induſtry have invented Arts to ſupply this defect, and amongſt many, the Teleſcope (which occaſion'd the enſuing Treatiſe) is one of the

moſt uſeful and curious Inſtruments that has hitherto been diſcover'd. By the help of it, Men are in ſome meaſure reſtor'd unto their firſt Dignity, and ſomewhat enabled to ſee and Contemplate the wonderful frame and diſpoſition of the Heavens and Heavenly Bodies, and thereby raiſe their thoughts and affections from Earthly groſs and mean Objects, to ſuch, which from a *Primum Mobile*, may advance them to the firſt Mover and Creator of all things. But as the Eye of Nature carries us but a little part of this way, ſo alſo this Artificial Eye falls very far

ſhort

short of the Mark; and though it communicates unto us some imperfect glimmerings of the Stars, Firmament, and Lower Heavens, yet it there leaves us at a loss; so that 'tis absolutely necessary to take some other help to guide us to the sight and fruition of the Supream Happiness, and that is the Eye of Faith, purely abstracted from all Sensitive Matter, which alone can penetrate through the Fogs and thick Vapours of the Air, and can like the Eagle stedfastly (through the Veil of the Firmament) behold the Sun of Righteousness. This Eye is only to be obtain'd by the

the constant and Conscionable hearing and reading the Word of God, which by some years Experience I observ'd you to perform, and question not your perseverance therein, having receiv'd as many and great Blessings from His Liberal Hand as any Heart can reasonably wish.

A Person of Quality, unto whom I have a thousand Obligations, was pleas'd lately to shew me the following Collections of Discoveries, made by many famous Astronomers of *Europe* touching the Planets and some others Stars, intimating that

that the time would not be ill spent to render it into *English*. I being very sensible of his great Wisdom and Judgment, readily contributed my weak Endeavours to communicate it unto all that are Well Wishers unto these Sublime Speculations; And having for an Age past been ambitious to give some publick Demonstration unto the World (as I have done in several particular Rencounters unto your self) of my Gratitude for the many Favours you have been pleas'd on all occasions to confer upon me both in City and Country; Although

I cannot with a *D'Avenant* or *Cowley* fix your Illustrious Name amongst the Stars, by the Rolling Measures of Pindarick or Heroick Odes; yet I do with no less hearty Resentments, according to my slender ability, here fitly place your great Name (as a Member of the most famous Society in the World) in the Front of the choicest part of the most Eminent of the Heavenly Stars and Planets; And that it may for many Lusters of Ages, flourish and shine with them above, as you have done here below, and convey their happy

py Influences upon you, shall ever be the desire of,

Honoured Sir,

Your most humble, and most Obedient Servant,

Jos. Walker.

To

TO THE READER:

THey must be very great Strangers to the Genius of our Nation, that will go about to deny them to have made as great progress in Astronomical Speculations, as any others whatsoever. Yet knowing the active mind of Men is inquisitive after new things, meeting accidentally with this small Treatise of Telescopes, and finding it to have been received beyond Sea with a general

ral Applauſe and Approbation, and Printed at Paris, Avec privilege Du Roy, *and ſuppoſing it as fit as other Subjects to make a progreſs into* England, *I thought it would be no diſſervice to the Curious to lend it my help and aſſiſtance in putting it into an* Engliſh *Garb, and in recommending its Fate unto all Well-Wiſhers of the Mathematicks.*

An

An Account of the Marvelous Aſtronomical Diſcoveries of late years made throughout Europe *by the help of Teleſcopes, &c.*

SECT. I.

Of Teleſcopes.

THe Teleſcope or great Proſpective-Glaſs was invented in the beginning of this Age, before which time none in the World had knowledge of it. Formerly it was made very little and ſhort, but finding that it repreſented Objects much better being made in a larger form, it is now made 20, 30, and unto 60, or 80 foot long, whereby Objects at great diſtance are clearly and more diſtinctly ſeen and diſcovered. Some do judge

 they

they may be made of such a capacity, or improv'd to such form, that by them may be seen the Inhabitants or Animals, which by some are pretended to be in the Moon; Wherefore according to the Opinion of Mr. *Azout*, the matters hereafter mentioned, appear but as Objects of 60, or 70 Leagues distant. We will here report the Testimony of several famous Artists and Astronomers, who by the means of this Instrument have made their Observations upon the Stars and Heavens, each in their own Country, *viz.* some at *Paris*, others at *Rome*, others at *London*, and others in several other places of *Europe*.

SECT. II.

General Discoveries made by the help of Telescopes.

1. BY means of this curious Instrument, it hath been observed, that all the Planets and Stars, excepting the Sun, are so many *Opaque* and *Dense Bodys*, without any light whatever, but only what they borrow of the Sun.

2. That every one of the Planets, except the Sun, change their Faces like the Moon; so that *Venus* and *Mercury* do sometimes

times appear like a half Moon, and ſometimes quite round, according as theſe Planets are found more or leſs oppoſite unto the Sun. That *Mars* ſometimes appears in a Curvy Lin'd Figure. That *Saturn* ſhews himſelf as encompaſſed with a Ring. Touching *Jupiter* it is very marvelous, That there are diſcovered four little Stars that continually move Circularly about his Body, and which by that means caſt a ſhade upon his Superficies. Theſe things are undeniable Teſtimonies, that all theſe Planets have no other Light, but that which the Sun communicates unto them.

3. This Teleſcope doth alſo inform us, that each of theſe Planets, except the Sun, have ſpots in their Superficies, juſt as the Moon hath, and of the ſame kind of blackneſs.

4. The ſame Inſtrument hath alſo inform'd us, that each of theſe Planets, and the Sun alſo, together with the daily and Natural Motions, do beſides, move themſelves upon their Centers, ſome by the motion of Revolution, and others by that of Libration.

SECT. III.

Discoveries in the fixed Stars.

TOuching the fixed Stars, it is marvelous that the same Four things which we have observed to be in the Planets, are also found to meet in them. Hereupon it is to be observed, that from time to time by help of the same Instrument, there is discovered new Stars in the Firmament, the which having appeared a certain time, do so decrease of their bigness, that they cannot any longer be discerned; and then afterwards, after the revolution of Months, Years, or Ages, do appear again, as if they were newly come into being. This Wonder hath given occasion unto Astronomers and Modern Optists to conclude, that it is the same with the Stars, as with the Planets; and that at least some of them, have Spots and Blemishes, and that they also move as those do, on their Centers; From whence it proceeds, that when their Spots are turn'd towards the Earth, they do not appear unto us; and when the Spots are turn'd t'other way behind, then they do appear by means of this great Luminary. This Remark imports an evident decision of the Question unto this day controverted, to wit, whether

ther theſe Stars ſhine of their own proper Light, or of the Light borrowed from the Sun-Beams, and we muſt hold it in favour of the Affirmative, that they ſhine by virtue of the Illumination of this great Planet; which is the point we have Eſtabliſhed in the firſt part of our *Anticopernicus*; There be a great many obſervable and curious things to be ſeen in this firſt Part. As for the Stars which are permanent, or do always ſhine, it may probably be ſaid, that they always continue ſuch, becauſe that by their moving upon their Center, they have little or no Spots. Moreover this Proſpective diſcovers unto us in the Heavens, a far greater number of Stars than what we can diſcern with the naked Eye. It diſcovers unto us in the Pleiades, in a Circle of one degree of Diameter which encompaſſeth them, the number of 46 Stars, whereas we can perceive in that little company but ſix, the ſeventh having diſappeared a long time agone.

Behold here alſo another great marvel in the fixed Stars, which is, that when they are beheld with the Teleſcope, they appear ſo prodigiouſly ſmall, that whereas *Tycho B.* tells us that thoſe of the firſt Magnitude appear unto the naked ſight about two Minets Diameter; they appear not unto us, according unto *Galileo*, but five Seconds of a

Diameter, which is twenty four times less. And whereas *Tycho B.* makes these Stars to be 60 or 70 times bigger than the Earth; at this time, on the contrary, they are found to be 200 times less than the Earth. Whereupon *Kepler* warns us, that with the Telescope the greatness of any fixed Star cannot be determined, because by how much the better the Glass is, by so much the lesser the Stars appear. It is a matter of surprise to hear, that all the Planets do appear greater in the Glass than they are, especially the lowest; and then again these fixed Stars on the contrary, with the same Glass, do appear smaller. I adhere unto this Opinion of the prodigious smallness of fixed Stars; Nevertheless at present I judge, that as to this matter, there is some kind of fallacy in our sight. Hereafter we will make a farther Demonstration.

Lastly, The Telescope has discover'd and decided the Question which hath been so long agitated amongst the ancient Philosophers, namely, what that is which we call the Milky Way, vulgarly in *French* the Way of St. *James*; for it has given us to understand, that 'tis nothing but an infinite multitude of small Stars, which by their nearness one to another, make up all that white Tract which we behold in the Heavens.

SECT.

SECT. IV.

Of what has been Obſerved in the Sun.

BY help of the aboveſaid Inſtrument, there has been obſerved upon the Convexity of the Body of the Sun, black Spots which are moveable, variable, and ſubject to change, and which do move regularly towards the Weſt, finiſhing their Revolution in 26 or 27 days. Nevertheleſs *Hevelius* here traces theſe ways by bendings, ſometimes Convex, and ſometimes Hollow. The motions of theſe Solar Spots teſtifie unto us, that the Body of the Sun turns upon his Center, with that motion. Theſe Spots are not Celeſtial Bodies, as *J. Tarde* would make us believe, but rather Evaporations which riſe from the Body of the Sun, after the manner of Vapours ariſing from the Earth, and forming themſelves into Clouds; which doth appear, inaſmuch as theſe Spots are always changeable in their form, bulk, and configuration. Sometimes there appears a great number in the Face of this Star: ſometimes but a few, and ſometimes none at all. Some of theſe Spots ſhine and become lightſom, and others that ſhined become dark. To this purpoſe *Malapert* at *Arras* did dayly obſerve theſe Spots,

from the year 1618. unto the year 1627. and never found them return unto the same Configuration they had in all that time, *Scheiner* on the other hand observed them at *Rome* at the same time, and found them no otherwise than the former had done.

It were to be wished that some of these Solar Spots had remained fixed in the Body of the Sun, for that would have decided the great Question, to wit, if it be the Earth, or the Sun, which is immovable in the Center of the Universe.

Father *Kirker* with the help of this same Telescope, in his Description of the Subterraneous World, *Lib.* 2. finds and tells us, that this great Star is a Body of Fire, unequal in its surface, and compos'd of several parts, of a different nature, some whereof is fluid, and others solid; that it appears, that his Disque is a Sea of Fire, wherein is perceived a perpetual agitation of Waves of Flame. That in some parts may as it were be seen Burnings, and in others Spots, much like unto thick Smoak; that these Burnings, and these Spots are not without the Sun, but that they seem to proceed forth from his Disque, appearing and disappearing, increasing and decreasing, the Fire shewing it self casually amongst those black Smoaks, which are the Spots that we perceive in this great Luminary; In short they

are

are the foams or froth of the Fire which the Sun exhales and evaporates out of its Body. Nevertheless Mr. *Azout* and Mr. *Hugens* do think, that these foams of Fire are only appearances occasioned by the undulation or waving of the Air. Some do esteem that these Solar Spots are the Seed and Matter whereof Comets are formed, which is not improbable. Moreover these same Spots of the Sun discover unto us, the reason wherefore in *Charlemain*'s time, there was discover'd a Spot in this great Luminary.

Also, Wherefore at certain times it was, that this Star appeared not in his wonted brightness, as it happened in the year 1547, from the 24th of *August* unto the 28th. that the Sun appeared reddish, and not as bright as the Moon in her total Eclips, so that several Stars were visible at Noon-Day.

It happened to be the same for a whole year together at the time when *Cæsar* was Murdered, insomuch that it was so darkned, that it could scarce ripen the Fruits of the Earth, *Virg. Geor. Lib.* 1. *& Ovid. Metam. Lib.* 15.

It was then by reason of Evaporations of the Sun which cover'd its shining face, and darkned its light, and diminished its heat.

SECT.

SECT. V.

Of what hath been Observed in the Moon.

BEsides what is commonly to be seen in the Moon by the naked Eye, to wit, that she changeth her Face according as she turns towards the Sun, and that together with what Light she hath, she hath also black Irregular Spots; the same Instrument hath farther inform'd us, that the Lucid parts of her Body are Rugged and Protuberant, and as some conjecture, is like the Earth; and the rest which consists in Spots, as the same Authors say, resembles the Sea. Also that the Surface of this Planet is set all over with certain round hollows like Pits or Wells, of several Magnitudes, all and every of which, some unadvisedly take to be so many Mountains; but that they are rather a kind of Cavities, and liker Wells or Pits than Mountains, is apparent, in regard their shade is towards the Sun and not opposite, that is to say, beyond these Concavities or Wells.

And these be all the Shades which is remarkable in the Disque of the Moon, for to imagine as a great many do, that these Spots are so many Shadows produced by the Sun, by reason of Hills and Valleys, which all

all Antiquity ſuppoſed to be in the Moon, is not true; for when the Moon is full and oppoſite to the Sun, theſe pretended Shades in this Planet ſhould by conſequence diſappear, which yet is not ſo. Note, That in our Figure, all the aboveſaid hollows, are repreſented without ſhade, becauſe being a Figure of the Full Moon, the Sun doth throughly enlighten them at other times, as at the Quarters, they ſhew themſelves ſhaded in the part towards the Sun.

And although the Face of the Moon is full of Wrinkles, yet nevertheleſs there appears no Shadow, whether it be that the Shades of theſe Wrinkles are inſenſible for their ſmalneſs, or elſe that they be tranſparent to the Sun Beams, which is the Opinion of *Galileo*, who eſteems the Moon to be like the Mother of Pearl, ſhewing knobs and rednes where there is none.

It is true that ſome of theſe Wells or Hollows ſeem to be all black in the Full Moon, but that is without doubt, becauſe that theſe Cavities are of the nature of the Spots whereof we ſpeak.

The Diameter of theſe Wells or Pits conſider'd in regard of the Moon, which contains about 650 *French* Leagues, contain ſome more ſome leſs; the greateſt of all is that of *A. B.* which by computation contains about 20 Leagues.

Let

Let us farther observe in this Planet the admirable mixture of its Lucidities and Spots, those surprising Varieties, those Resemblances of Forests of Rushes which seem scatter'd here and there: those kinds of Spiders Legs: those kinds of Polygones, and especially the appearances of Beams of Light arising out of these profound Wells, as of the abovesaid *A. B.* To conclude, all the great variety of these things cannot seem to happen by chance, but that they were so disposed by the Soveraign Creator, for some end and reason unknown unto us; And indeed the Eighth *Psalm* informs us, that this Planet, as also the Stars, is the work of Gods Fingers.

Mark the word, Fingers.

All which being consider'd, and for other Reasons, we cannot say that the Moon is a World filled with Inhabitants, Animals, and Plants, as many ancient Philosophers have imagin'd; but rather a certain Vapour or Cloud, probably condensed with Cold, which is evident, inasmuch as this Star by day appears as a common Cloud; which Cloud were it raised to the height of the Moon, and that it were as big, it would shine in the Night after the same manner. Add hereunto, that the Pillar of the Cloud which conducted the *Israelites* in the Wilderness, was a Cloud by Day, and a Pillar

of

of Fire by Night. We judge that all the Stars of Heaven, except the Sun, are of the ſame ſubſtance the Moon is of.

It is moreover a great wonder that this Nocturnal Light, appears unto us here below, to have borrow'd the likeneſs of a Womans Face in her Diſque. *Plutarch* hath writ a Treatiſe expreſſly, wherein he ſaith this Figure of a Human Face, was in the Mouth and Hands of all the World; although it is certain that ſome of great Wit and exquiſit Judgment, do proteſt they do not perceive any Image of a Womans Face in this Planet. But *Plutarch* himſelf gives a Reaſon of this miſtake, ſaying, that it is becauſe thoſe People have the ſight low and weak, uncapable of well perceiving the Lineaments of this Face; or rather, it is becauſe their thoughts are not intent upon the Deſign, Picture, or Portraicture. For my part before I attained to be Six years of Age, I already fancy'd the form of a Face in this Planet, which alſo moſt People in the World think they do.

Beſides let us obſerve this Face in the Moon with the Teleſcope, and let us conſider it altogether, and ſeverally; then you will ſay, this Human Face will no more be ſeen, but only certain Irregular Vapours without any order, which have no likeneſs unto any Repreſentation whatſoever.

1. Our

1. Our Teleſcope hath alſo inform'd us, that there is firſt an Atmoſphere, or Orb, which is ſuppoſed to be of a very thin Vaporous Air, which encompaſſeth all the Superficies of the Moon; as round the Earth there conſiſts the like Orb of Vaporous and Cloudy Air, which containeth the firſt Regions of the Air.

2. The Teleſcope hath farther given us to underſtand a thing very ſurpriſing in the Moon, which is, that in her Eclipſe, when it is Eclipſed a Fingers breadth or two, to the Naked Eye, it is not at all Eclipſed if you look on it with the Teleſcope; and when it is quite freed from the Eclipſe in the Teleſcope, it yet appears to be Eclipſed a Finger or two's breadth to the naked Eye. Upon this matter ſee the *Hydrogr.* of Father *Fournier*, wherein are given ſome Examples of this Phenomenon.

3. This Teleſcope hath farther given us the knowledge of a thing more ſtrange and wonderful, to wit, that although the Moon being low near the *Horizon*, appears greater unto the naked Eye, and being mounted towards the *Zenith* appears leſs; it is found, that when its Viſual Diameter comes to be meaſured in both theſe places, the quite contrary doth appear; to wit, that ſhe is leſs when ſhe is low near the *Horizon*, and greater when ſhe is mounted towards the *Zenith*.

4. Let

4. Let us inſtance in a fourth thing which relates unto the Moon, which is, that although for time out of mind, it hath been believed that the Longitudes of the World may be obtained by means of the Eclipſes of this Planet; nevertheleſs Obſervations do not thereto agree, and do very much diſagree from the Longitudes of our Maps of the World; whereupon ſee the *Hydrogr.* of Father *Fournier*, which gives a greater number of Examples. Let us add another point no leſs ſurpriſing; which is, that although that which is Illuminated in the Moon proceeds from the Rays of the Sun darted directly upon her; When this brightneſs comes to be examin'd, it is found that in all likelihood it is not carry'd in a direct Line, but in a crooked, and ſeems not to proceed from the Sun as from its Source, but ordinarily from another Principle higher and more eminent. God willing we will give full ſatisfaction of all theſe *Phenomena's* in a particular Treatiſe.

SECT.

SECT. VI.

Of what hath been discover'd in Saturn.

TIme out of mind it hath been conceived that this Planet *Saturn*, consisted in one entire round Globe; but now by help of this Telescope, we discover that it is composed of two parts, and that indeed it is round in respect of its Body, but doth besides consist of a Ring, which is Luminous by means of the enlightning of the Sun, as *Saturn* himself is Luminous by the same means; which Ring encompasseth him all round after the same manner that the *Horizon* of our Artificial Globes encompasseth their Globes, and is flat upon the Verge as they be. Moreover this Ring shews not it self round, as a Circle seen direct, but shews it self in an Oval, as a Circle seen Obliquely. Some have at certain times found it twice and an half longer than it is broad; others have found it decline from the Ecliptick 31 Degrees; whereupon see here what is strange, which is, that upon certain Occurrences and Times this Ring disappears, so that at that time *Saturn* is alone and quite deprived of his Ring, just as the Figures here do represent, whereof the 1, 2, and 3, do shew the manner

manner that this Planet doth commonly shew himself with his Ring, and the 4th when he shews himself without a Ring, and quite round. Upon this change of Figure, wherein *Saturn* at certain times appears, Astronomers have well concluded, that in effect he moves in himself, and that it was necessary this Circle should be flat like a Bourlet; and that the reason wherefore he disappeared at certain times, proceeded, that at that time, he was as to us, turned Profil, and shewed us the side, and was not enlightned with the Sun on the side turned towards us. Moreover, Observations have given us to understand, that this Planet moves upon his own Center, and upon his own Ax, to wit, under the *East*, to the *West*, as has been observ'd by *Hugens*, *Cassiny*, and others. Touching the Motion of this Planet Mr. *Hugens* has observed, that when it arrives at the 20th Degree and an half of *Pisces* and *Libra*, it appears round and without Arms. To this purpose in the year 1671. at the end of *May*, it appeared all round; and also in like maner it will appear all round in the year 1685. which is about fifteen years afterwards, which will also continue from fifteen to fifteen years, which is the moiety of the Natural Motion of this Planet, which 'tis known compleats his course in about thirty years.

Besides there is farther observed in this Planet a little Moon, which like the Satellites of *Jupiter* continually runs round his Body, and finisheth their course in the space of fifteen days thirteen Minutes. Mr. *Azout* thinks that in a few years the shadow of this same Moon may be seen upon this Planet.

SECT. VII.

Of what hath been Observ'd in the Planet of Jupiter.

WIth the help of the same Instrument there is observed in the Face of *Jupiter*, and overthwart his Luminous part, three darkish Belts, like unto the Spots which appear in the Moon; These Belts or Girdles which encompass or begirt this Planet, shew themselves all streight and parallel, and extend from *East* to *West*, near after the manner of the Ecliptick; and do make as it were a kind of Equinoctial and Tropicks, of an Artificial Sphere; Of his Belts the more Southern is a little larger than the Northern, besides that it is a little nearer the *South* than the other is unto the *North*. Mr. *Hooke* hath particularly observed also a little dark Filament, and where

these

theſe Girdles or Belts draw nearer the *Poles*, the *Zones* grow darker, as in *A. B. Fig.* 2. Some Obſervators remark theſe Belts with ſome Curvity, but its border appears perfectly round, and without radiation.

Moreover this Planet hath four little Stars or Moons, which are not viſible unto the naked Eye, which do continually move round his Body, and which do riſe in the *Eaſt* of him, and ſet to the *Weſt*. Theſe four wonderful little Stars are called the Satellites, or the Guards of this Planet; they are diverſly diſtant from *Jupiter*, and thoſe neareſt his Body finiſh their Revolutions with greater expedition than thoſe that are fartheſt off.

1. The neareſt of the Satellites is diſtant from *Jupiter* three minutes, and finiſheth his courſe in eighteen hours, twenty eight minutes, thirty S.

2. The ſecond Satellite is diſtant from *Jupiter* five minutes, and endeth his Revolution in three days, thirteen hours, eighteen minutes.

3. The third is diſtant eight minutes, and finiſheth his Revolution in ſeven days, three hours, thirty five S. and is greater and brighter than the others.

4. The fourth Satellite is diſtant from *Jupiter* thirteen minutes, and endeth his

Courſe in ſixteen days, eighteen hours, nine minutes, fifteen S.

It is to be obſerved that theſe Satellites do give a ſhadow upon the Body of *Jupiter*, when they are found interpoſed betwixt the Sun and him. Moreover Mr. *Caſſiny* of late hath obſerved two moveable Spots upon the Face of this *Jupiter*, which do make their Revolution upon the Center of the ſame, tending towards the *Weſt* in nine hours, fifty nine minutes; The which by Conſequence doth teſtifie, that this ſame Planet moveth upon his Center from the ſame part likewiſe in nine hours, fifty ſix minutes. This Period is the ſhorteſt of all thoſe that is made in the Firmament.

SECT. VIII.

Of what hath been Obſerv'd in the Planet of Mars.

ACcording to Mr. *Caſſiny*, *Mars* doth move upon his Center and upon his Ax, under the *Eaſt*, towards the *Weſt*, and with a Direction very like that of the Ecliptick, that is about twenty four hours, forty minutes each Revolution; the which he diſcover'd by means of two notable inherent movable Spots upon the Superficies of

of this Planet, and which do both finiſh their Courſe in the ſame ſpace of time.

It is to be obſerved that *Mars* in his Oppoſition doth always appear round; but when he is betwixt the Conjunction and Oppoſition, he appears in a Curvy Line Figure; like the Moon when ſhe is near her Oppoſition, before or after him.

SECT. IX.

Of what hath been Obſerv'd in Venus.

THis Planet *Venus* appears ſometimes round, ſometimes half round, and ſometimes like a Creſſent. Mr. *Caſſiny* took notice of it, and did not ſufficiently, nor ſcarce at all underſtand it, until the year 1666. which he did not then neither, ſaith he, without much difficulty. He found that it had Spots upon its Surface juſt as the Moon has; to wit, two, which are very thin, long, and uncertainly terminated; amongſt which at the ſeventh place marked 7, appears a ſhining part. He found by means of theſe Spots, that the motion of this Planet and of its Spots, was made upon its own Center, and upon an Ax which carry'd it from *South* to *North*, which is a motion wholly unknown in the Heavens;

and that this motion was accomplisht in one day, whether it be, saith he, of Revolution or Libration.

SECT. X.

Of what hath been Observ'd in Mercury.

TOuching *Mercury* we have no Observations can say that he hath Spots, as the other aforesaid Planets, nor can we determine whether he turns or not on his Center, or on some Ax; Nevertheless it is probable to believe, that it hath all things just as the other Heavenly Bodies. Moreover, *Hevelius* in the year 1644. observed, that he changed his Face, just as the Moon and *Venus*; and that he appeared sometimes round, sometimes half round, and sometimes like a Cressent. The reason wherefore this Planet is not discerned like the others is, because of his smalness, and for its being commonly darkned by the Sun Beams.

The 7th of *November* 1631. this *Mercury* was seen in the Disque of the Sun, as it were to Eclipse it; and there appeared like a Spot of the eightieth or ninetieth part of the Diameter of this great Star; It had its Center very black, and the Extremities something red.

SECT.

SECT. XI.

Of new Stars which appear for a time, and then disappear at another time.

And First,

Of the first which came to our knowledge, and of the Notable One which appeared in the Chair of Cassiopea, Anno 1572.

THe first new Star come unto our knowledge, is that which appeared in the time of *Hypparcus*, about 125 years before the Birth of our Saviour Jesus Christ; Since which time some others have also been discovered; to wit, one in the year 388, whereof *Claudian* makes mention: and one in the fifteenth Degree of *Scorpio*, spoken of by *Albumazar Haly*, the which continued four Months. Since which time, in the year 1571. the Ninth of *November*, there appeared in the Firmament in the Chair of *Cassiopea*, that notable Star of the first Magnitude, which in its Course governed it self like the other Stars, as holding place amongst them, and had no Paralax. The Astronomers of those times well observed it, for Instance *Tycho B.* it continued sixteen Months, after which time

decreasing very much, it grew quite invisible.

Upon the Consideration of this Star or Comet, is remarkable unto our purpose, what the Marquess of *Villenes* hath left in Writing in his Book upon the *Centiloqui* of *Ptolemey*; to wit, that there remained a black Spot in the same place where this Star appeared; which, if so, it would the more confirm what we have said, that the Stars have Spots just as the Planets have, the which makes them disappear at such times as they turn fromwards the Earth. Nevertheless seeing the Assertion of this Marquess is not seconded by other Authors, we will refer our selves unto farther Experience.

It is doubtful if this same Star will not come and appear again. All we can conclude of this Question is, that if it be a real fixed Star, it will not fail appearing some other time; but if it be only a Comet, or that it is in the Firmament it self, or a little below it, then it will never appear again.

SECT.

Pag. 24.

The new STARR or Comet in the Constellation of Cassiopea observed by Tycho Bt

Fig: 7.

SECT. XII.

Of the Star in the Swan's *Breaſt.*

NIne and twenty years after the Apparition of the Star in *Caſſiopea*, *viz.* in the year 1601. there appeared in the Heavens a new Star of the third Magnitude, in the *Swan's* Breaſt, which continued viſible unto the year 1626. and then totally diſappeared. *Kepler* obſerved it very diligently.

After it had diſappeared, and in the ſpace of thirty three years, to wit, in the year 1659. Mr. *Hevelius* at *Dantzick* obſerved it to appear again in the ſame place where *Kepler* firſt ſaw it, and of the ſame Magnitude, but in the year 1660. it ſeemed plainly to diminiſh, and quite diſappeared ſoon after. Again in the year 1666. Mr. *Hevelius* ſaw it re-appear, and it continues at preſent to be ſeen, but ſo ſmall, that it is but of the ſixth or ſeventh Magnitude. It is ſuppoſed that it is no leſs than fourteen years in finſhing its Revolution; We have here repreſented it in *Tab.* 8.

Of the Star near the Swan's Bill.

This Star was first discovered by *Dom. Adthelm, Chartreux* of *Dijon*; to wit, in the year 1671. it appear'd unto him of the third Magnitude; It is not mentioned in any of the Catalogues of Stars, although a great many much more inconsiderable ones be therein mentioned. The same Father, and Mr. *Cassini*, have observed it as well in its increase as in its decrease; It hath twice appeared unto them in its greatest Luster: the first time the fourth of *April*, and the second time the first of *May*; it is about a Month in its return to its first state.

SECT. XIII.

Of the Star in the Whale's *Neck.*

THis admirable Star in the *Whale's* Neck is of this sort also which appear sometimes, then hide themselves, and then disappear again to appear at another time. At first it appears to be but of the sixth Magnitude, then it increaseth by little and little for 120 days together, after which time it arrives at its full period and greatest brightness and eminency, which is, to be

of

of the third Magnitude, wherein it continues fifteen days together, then it decreaseth until it becomes invisible.

It doth appear every year in this greatest brightness, thirty two or thirty three days sooner than the precedent year, and compleats its Revolution in about three hundred and thirty three days. Mr. *Bouillean* Astronomer hath very diligently observ'd it; he thinks it moveth upon its own Center and Ax; and presupposeth as we do, that it is composed of two different parts, the greater obscure, and the less bright; remaining invisible when the obscure part is turned towards us, and shewing it self when the bright part is towards us. Astronomers have judged that its motion is Irregular and inscrutable; nevertheless the said Mr. *Bouillean* has invented a very ingenuous Hypothesis, whereby he makes its motion to be Regular.

SECT.

SECT. XIV.

Of the Cloudy Star of the Girdle of Andromeda.

FAther *Fabry* and Mr. *Bouilleau* above-said, have taken notice of this Star; it appeared in the years 1612, and 1613, and then disappeared until the year 1664. that it appeared again anew.

SECT. XV.

Of the Star betwixt Eridanus *and those of the* Hare.

MR. *Cassiny* has discover'd another new Star situate betwixt *Eridanus* and the *Hare*, the which also shews it self, and then withdraws it self as the others above-mentioned, and is in the passage whereby the Comet in 1664. went. No body has spoken of this Star, although it be one of the fourth Magnitude.

SECT. XVI.

Of other Stars, of which it is very probable that they are new Stars.

THere is one of the fourth Magnitude and two of the fifth in *Caſſiopea*, which in all likelihood be new Stars, for ſeveral Aſtronomers having given an exact Account of far leſſer Stars of this Conſtellation, yet have made no mention of theſe three. Moreover there is one of the fourth and one of the fifth Magnitude at the beginning of the Conſtellation of *Eridanus*, of which it is certain they were not there in 1664. becauſe in that part of the Heavens the Comet of that year paſſed; and the very ſmalleſt Stars were diligently obſerved, whereas theſe which were far more conſiderable, were not obſerved.

Mr. *Caſſiny* hath alſo obſerved four Stars towards the Artick Pole, which are of the fifth and ſixth Magnitude, which the Aſtronomers which have their Eyes always fixed on this part of the Heavens, would not have omitted to have inſerted in their Catalogues, if they had ever appeared heretofore.

SECT.

SECT. XVII.

Of Stars which have appeared heretofore, and now disappear.

Time out of mind there has seven Stars been observed in the Pleiades; The sacred Text, *Amos* 8. *v.* 5. seems to speak of this number, and probably also *Revel.* 1. and at present there is to be seen but six, a very probable sign, that one of them is retired and become invisible, after the manner of these abovementioned.

One of these of the Constellation of the *Little Bear*, which was formerly visible, doth not now appear.

Another also in the Constellation of *Andromeda* hath also disappeared.

That also in the Extremity of the Chain of *Andromeda*, in like manner hath disappeared, or at least is become so very small, that it is in a manner impossible to discern it.

Another which *Tycho B.* has inserted in his Catalogue for the twentieth of *Pisces*, hath also disappeared.

Now some may imagine that the abovesaid Stars may become invisible for a certain time, that the Sky in the place where they are, is thicker than ordinary, but that is not

not it, because when these Stars become invisible, nevertheless the neighbouring Stars, although much smaller, and as it were imperceptible, yet are seen and discover'd; The new Star abovementioned which was in the passage of the last Comet, disappeared, whilst other less Stars in the same passage continued constantly to be seen.

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An

An Abstract touching the Distance, Bulk, and Orbs of the Heavenly Bodies; The best way of using Instruments, &c. for satisfaction in the truth of the foregoing and like Discoveries; Out of the best Astronomers ancient and modern.

SECT. I.

A Brief Method to satisfaction in the truth of the foregoing and all like Discoveries.

IN order to make a true Estimat of the certainty, or at least probability of the former Discoveries, I know no better way than to consider first the Distances of these Heavenly Bodies; then their Bulk and Bigness; next, their Spheres,

Spheres, or the Circumference of their Orbs; and laſtly, the beſt means and times of making uſe of ſuch Inſtruments by which exacteſt Diſcoveries may be made. All which we will ſet down according to the beſt and moſt uſually received Accounts amongſt the Learned, both ancient and modern, with all poſſible perſpicuity and brevity.

SECT. II.

Albategnius and *Alphraganus*, with others who have improved *Ptolemey*'s Doctrine and Obſervations, adjuſt the diſtances of the Planets and Stars from us, by the Semidiameter of the Earth, taking that as the firſt and beſt common Meaſure; and the ſame meaſure have our Modern Aſtronomers taken up from them, for Reaſons which may be touched hereafter. Now the Semidiameter of the Earth we cannot but think may be in a very tolerable ſort computed and aſcertained by reaſon of the great Improvements of Navigation, and the frequency of paſſing to and fro in a manner from Pole to Pole; I mean within few Degrees of each, and from the *Eaſt* and *Weſt-Indies*, and back again, *&c.*

Now though there have been divers Opinions of the Compaſs of the Earth, yet it is now in a manner agreed upon that it is of 20255 *Italian* Miles; and that the Diameter thereof is 8354 ſuch Miles; Therefore the half Diameter, or Semidiameter muſt be 4177 ſuch Miles. Note, That the *Italian* Mile conſiſts of 1000 Geometrical Paſſes; Now a Geometrical Paſs contains five Foot, and muſt not be confounded, as by ſome Ignorant People it is, with our common Yard.

SECT. III.

Of the diſtance of the Moon from the Earth, the compaſs of her Orb, and bigneſs of her Body.

ACcording to thoſe forementioned *Arabians*, the mean diſtance of the Moon (that is taking her when ſhe is neither fartheſt off from, nor neareſt to the Earth, but in a middle motion) is forty nine half Diameters of the Earth: that is about 1103881 *Italian* Miles.

This it is plain *Copernicus* thought too little, and therefore went not about any particular Calculation of her diſtance, but only in general has told the World, he looks upon

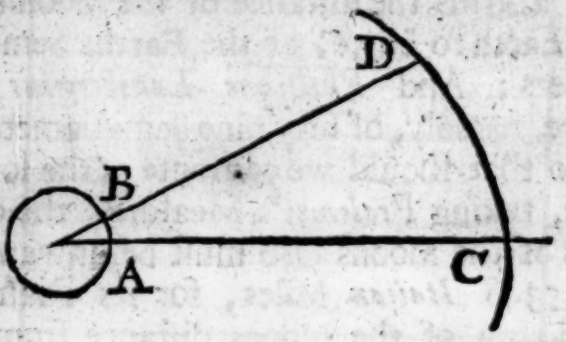
upon the compaſs of the great Orb to be ſo vaſt, that the Earth compared thereto is only as a Point; But *Tycho Brahe* having made ſtricter Obſervations and Calculations, affirms the diſtance of the Moon from the Earth to be 56½ of the Earths Semidiameters; And *Philippus Lansbergius* yet more, namely, of fifty nine Semidiameters.

So that ſhould we compute at the loweſt rate, taking *Ptolemey*'s Meaſures, the compaſs of the Moons Orb muſt be upwards of 6645348 *Italian* Miles, for its Diameter made up of the Moons diſtance from the Earth twice taken, and of the Diameter of the Earth will be 2215116 Miles, which multiplied by three (the round number, to avoid Fractions) gives the forementioned Sum; A vaſt Orb indeed, yet far the leaſt of any of the Planetary ones.

Now as to the bulk or bigneſs of the Moons Body, it is eſtimated commonly by the proportion it bears to the Body of the Earth. Thoſe that follow *Ptolomey* account it thirty nine times leſs than the Earth; But *Copernicus* tells us roundly 'tis about forty three times leſs; *Lansbergius* forty five times and an half; And *Tycho Brahe* forty two. *Utrum horum mavis accipe.*

There is another Meaſure which Aſtronomers apply to Heavenly Bodies, which they call a Degree; by that they mean an

Arch of a ſuppoſed Circle in the Heavens anſwerable to a Line of 60 Miles on the Surface of the Earth, which will be beſt underſtood by the following Figure.



Let the ſmall Arch intercepted between *A* and *B* be ſuppoſed to be 60 Miles in the Surface of the Earth, the Arch which anſwers it in a ſuppoſed and very far diſtant Circle in the Heaven will be the Arch intercepted betwixt *C* and *D* vaſtly larger, yet bearing a proportion to the leſſer Arch in the Earth. The Arch then *C. D.* is a Degree in the Heavens as *A. B.* is a Degree on the Surface of the Earth. Now theſe Degrees they ordinarily ſubdivide into ſixty parts, which they call Minutes or Scruples, and theſe again into Seconds and Thirds as they pleaſe. Thus meaſuring, the apparent Diameter of the Moon is eſteemed to be thirty three Minutes and one third. And thus much of the Moon.

SECT.

SECT. IV.

Of the diſtance of Mercury *and* Venus *from the Earth, the compaſs of their Orbs, and the bigneſs of their Bodies.*

AFter what has been ſaid of the Moon, all will be much plainer touching both the other Planets and fixed Stars, of which we will firſt conſider *Mercury* and *Venus*, whom we thus put together, becauſe they alſo, as the Moon, are commonly thought leſs than the Earth, though far more diſtant than the Moon.

Mercury is by the *Ptolomaicks* thought to be 115 half Diameters of the Earth diſtant from the Earth; but by *Tycho Brahe* 1150; and by *Lansbergius* 1500.

Now if we will reckon according to *Ptolomey*, *Mercury* will be 480355 Miles diſtant from the Earth, which number if we double, and add thereto the Diameter of the Earth, *viz.* 8354, we have the Diameter of his Orb, *viz.* 969064 —— Miles; which number if we treble, we have near about the compaſs of his Orb, *viz.* 2907192 ——— but if we take the other Accounts 'tis vaſtly bigger.

As to his Body, *Ptolomey* ſuppoſed him 19000 times leſs than the Earth, (a prodigious miſtake certainly) *Tycho Brahe*, who is more herein to be credited, only nineteen times leſs, (by which he ſhould be above as big again as the Moon) and *Lanſbergius* only twice leſs. His apparent Diameter is judged only of two minutes or thereabouts, but *Martinus Hortenſius*, a Diſciple of *Lanſbergius*, making uſe of his Teleſcope, admits *Mercury*'s Body to be only nineteen Seconds; which Computation may be amongſt others a good reaſon for his being ſo ſeldom ſeen.

Venus comes next; By the *Ptolomaick Syſtem* diſtant from the Earth 618 Semidiameters of the Earth; By the *Tychonick* 1150; By *Lanſbergius*'s 1500.

Now if we will reckon again according to the loweſt rate, which is that of *Ptolomey*'s, *Venus* will be 2581386 —— Miles diſtant from the Earth; which number if we double, and add thereto the Diameter of the Earth, *viz.* 8354, as above, we have the Diameter of her Orb; and that number if we treble, as before, we have (nearly) the Compaſs of her Orb, *viz.* 15513378 —— which yet it is apparent others would make vaſtly larger.

As

As to the bulk of this glorious Star, *Ptolomey* makes it twenty eight times leſs than the Earth, *Tycho* only ſix times leſs, and *Lanſbergius* but three and a third part. Her apparent Diameter according to the firſt is of three Minutes; according to the ſecond of three and a quarter; but *Martinus Hortenſius*, a Diſciple and Aſſiſtant of *Lanſbergius*, obſerving her by good Teleſcopes, ſuppoſes her Diameter only of fifty nine Seconds.

SECT. V.

Of the diſtance of the Sun from the Earth, the compaſs of his Orb, and bulk of his Body.

THe mean diſtance (for of that all along we would be underſtood to ſpeak) of the Sun from the Earth, the *Ptolomeans* reckon to be 1165 Semidiameters of the Earth; The *Tychonians* but 1150; (the ſame as of *Venus* and *Mercury*) *Lanſbergius, &c.* 1500. as he alſo had judged of theſe two laſt Planets.

Whence, if we ſhould compute at our former rate, it would follow that the Sun is diſtant from the Earth about 4866205 —— Miles; which number, if, as before, we

double, and add thereto the Diameter of the Earth, we have for the Diameter of the Solar Orb 9740764 Miles; and that if we multiply by the round number of Three to avoid Fractions, as before, we have for the compass of that Orb 29222292 Miles. The Body of the Sun, which is the greatest of all the Heavenly Bodies, is by the *Ptolomeans* judged to be 167 times greater than the Globe of the Earth and Sea; yet do they reckon his apparent Diameter only thirty one Minutes and one third, that is just two Minutes less than the Moon appears to us. *Copernicus* esteemed it only 162 times bigger than the Earth. But *Lansbergius* 434. And *Tycho Brahe* much less than either, only 139 times bigger than the Earth, and his apparent Diameter of thirty one Minutes still less than the apparent Diameter of the Moon; however his Body in it self be so vastly bigger.

SECT. VI.

Of the distances of the other Planets from the Earth, the compass of their Orbs, and bulks of Body.

WE will now cease to compute the distance of the Planets by Miles, as being

being too ſmall a meaſure, and running Figures to too great a length; The method is open enough, and any who have the curioſity to know the diſtance by Miles may be ſuppoſed to have the induſtry alſo, if they pleaſe, to calculate it themſelves.

Mars's mean diſtance from the Earth according to *Ptolomey* is Four thouſand five hundred eighty four half Diameters of the Earth; his apparent Diameter of one Minute and an half; and his Body once and an half bigger than the Earth. According to *Tycho* he is only One thouſand ſeven hundred and forty five Semidiameters of the Earth diſtant, and his apparent Diameter of one Minute and three quarters, and his Body thirteen times leſs than the Earth. Which laſt point of his Opinion *Lanſbergius* favours ſo far as to allow him to be eight times leſs than the Earth, but diſtant from it Two thouſand two hundred and ſeventy five of its Semidiameters. Now *M. Hortenſius* runs him ſo low as to reckon his Body to be One thouſand five hundred and thirty four times leſs than the Earth, and his apparent Diameter only of thirty ſix S. And according to our former rate and method, we ſhall have for the Diameter of his Orb Nine thouſand one hundred and ſeventy Semidiameters of the Earth, and for the compaſs of his Orb 27410 of the ſame.

Jupiter's

Jupiter's mean distance is according to *Ptolomey* Ten thousand four hundred and twenty three Semidiameters of the Earth; his apparent Diameter two Minutes and an half; and his Body eighty one times bigger than the Earth. According to *Tycho* he is only Three thousand nine hundred and ninety Semidiameters of the Earth distant from it; his apparent Diameter much at the same rate as the *Ptolomeans* judge it; but his Body only fourteen times bigger than the Earth. *Lansbergius* makes him Eight thousand and ninety one Semidiameters of the Earth distant from it; his Body but twenty five and two fifth parts bigger than the Earth. *Hortensius* but one and one fourth bigger, and his apparent Diameter only of fifty Seconds. And following still our former Computation upon *Ptolemey*'s Doctrine (the proportions of his *System* being a mean between the vast one which *Copernicus*, and the narrower which *Ty. Brahe* introduced) we shall have for the Diameter of his Orb Twenty thousand eight hundred and forty eight Semidiameters of the Earth, and for the Compass or Circumference thereof upwards of Sixty two thousand five hundred and forty four of the same.

Saturn the highest of the Planets comes last, whom *Ptolomey* placed Fifteen thousand and eight hundred Semidiameters of the

the Earth diſtant from it; *Tycho* but Ten thouſand five hundred and fifty; yet *Lanſbergius* allows the diſtance to be Fourteen thouſand eight hundred and eighty of the Earths Semidiameters. His apparent Diameter is judged by none, above one Minute and ſome odd parts, however his Body is according to *Ptolomey* ſeventy nine times, according to *Lanſbergius* forty ſix, according to *Tycho* but twenty two times bigger than the Earth. And at our old rate, the Diameter of his Orb will be about Thirty one thouſand ſix hundred and two Semidiameters of the Earth, and the compaſs of his Orb about Ninety four thouſand eight hundred and ſix of them. Thus far then of the Planets, their mean diſtance from us, their bulk, and Orbits.

SECT. VII.

Of the fixed Stars, their Magnitude and Sphere.

BEcauſe ſome have judged certain Comets to have mounted as high as the Sphere of the fixed Stars, being that they were not able to obſerve they had any Parallax, we will therefore here conſider thoſe Stars as we have done the Planets.

Ptolomey

Ptolomey (at least the forementioned *Arabians* deducing it from his Principles) have placed the fixed Stars Nineteen thousand Semidiameters of the Earth distant from it. *Tycho* honestly telling us, that no exact or certain measures can be taken in this case, conjectures them to be near about Fourteen thousand such Semidiameters distant. As to the *Copernicans* they have another way of measuring, of which anon.

The fixed Stars are judged very far from being all of a bigness; And since the invention of Telescopes, it is certain there are a multitude of them either so small, or so far off us, that they cannot be seen by our naked Eye; however according to the usual estimate, they are taken to be of six several Magnitudes. Those of the first rate are conceived One hundred and eight times bigger than the Earth; such are, the bigger Dog-Star, the Bulls-Eye, *&c.* Those of the sixth and least rate only eighteen times bigger than it, according to *Alphraganus* his Account; but *Albategnius*, his Brother *Ptolomaick*, varies a little, not very much worth insisting on. However behold his whole estimate of all the Mundane Bodies. *If we compare* (says he) *all the Mundane Bodies as to their bigness, we must acknowledge the Sun to take the first place, as biggest of them all; next him the fixt Stars of the first Magni-*

Magnitude; in the third place Jupiter, *in the fourth* Saturn, *in the fifth the reſt of the five Orders of the fixt Stars, according to their Magnitudes of* 2, 3, 4, 5, *and* 6th *Rate, in the ſixth place* Mars, *in the ſeventh the Earth, in the eighth* Venus, *in the ninth the Moon, in the tenth and laſt* Mercury. This is alſo generally the *Ptolomeans* Opinion of the ſeveral Bodies in this Syſteme of the World.

But I ſuppoſe it muſt be underſtood only of ſuch fixt Stars as they knew; for before the invention of Teleſcopes, that infinite number of Stars which makes up the *Galaxy*, or *Milky Way*, that great number alſo in the Conſtellation of the Pleiades, not ſeen to the naked Eye, as alſo the innumerable number *ſcattered through the Heavens*, diſcoverable by the help of our Glaſſes, were not known, nor therefore eſtimated.

The Diameter of the Sphere of fixt Stars, if taken according to our old Rule, is about Thirty eight thouſand and two Semidiameters of the Earth: and therefore its compaſs upwards of One hundred ſeventy four thouſand and ſix ſuch Semidiameters.

SECT.

SECT. VIII.

Of the Opinion of the Copernicans *in these points, and the advantage of their Systeme.*

NOw, *Copernicus* and his Followers placing the Sun in the Center of the World, and supposing the Earth to be moved both upon her own Center daily, and annually about the Sun, (which is far the most probable of any of the Mundane Systemes) measure the distance of the Sphere of fixed Stars by the Semidiameters of the great Orb; And the great Orb they call the Sphere of the Earths annual motion about the Sun. For the full understanding hereof, behold here the Systeme (or Fabrick of the World) according to the *Copernican* supposal.

The outermost Circle is the Sphere of the fixt Stars: The second is the Orb of *Saturn*, marked ♄: The third of *Jupiter*, who is placed in the four less Circles, *A. B. C. D.* in each of which Circles is a little Star (called one of his Satellites, or Life-guard-Men) moving round him: The fourth great Circle is the Orb of *Mars*, marked ♂: The fifth is the Orb of the Earth, marked 4, about whom in a little Circle, the Moon is by them supposed to move Monthly: The

sixth

sixth is the Orb of *Venus*, marked ♀: The seventh of *Mercury*: In the midst of all stands the Pavillion of the Sun, whom they suppose only to move about his own Center in twenty seven days or thereabouts, which is proved by the Spots observed in his Face by the help of our Glasses, which Spots make their returns to the same point in about that time. The advantages this Hypothesis has above the other, is too long here to insist on; Only I will say there are some very Learn'd Men, who no more doubt that the motion of the Earth will be received generally within a small compass of years, than that now Men believe the Antipodes, or the Circulation of Blood, and think it as much demonstrable as either of them.

Supposing then the Earth to be moved round, the Sun in the Circle here assigned to it, that Circle they call the great Orb, and suppose the Semidiameter of it to be equal to 1500 Semidiameters of the Earth, and the Sphere of the fixt Stars to be distant from the Earth 28000 Semidiameters of the great Orb, or which is much about the same, forty two millions of the Earths Semidiameters.

This distance indeed is vastly greater than either that assigned by *Ptolomey* or *Tycho*, but yet admitting the distances assigned by either of the two later, and measuring the

the compass of the Orb of fixed Stars thereby, it is in a manner unconceivable that that Orb can be carry'd round the Earth in twenty four hours, or in a natural day; for in such case its motion must be many hundred times more rapid or swifter than the Shot out of any Gun. For according to due Computation, the very Sun it self, by the *Ptolomaick* Hypothesis, must move in one minute 13095 *English* Miles, and in an hour 783715 Miles; but the fixed Stars most vastly more, namely 13513686 *English* Miles in one hour, and in one minute not less than 225228 Miles, which I think no one can well believe. Yet this I say would inevitably follow upon that distance at which *Ptolomey* places both Sun and fixed Stars from the Earth; and much more upon the distance assigned by the *Copernicans*, only those indeed help themselves by supposing the Earths daily motion upon its own Ax.

SECT. IX.

Of the best way and times of using Instruments to satisfie our selves in these Curiosities.

THat the Quadrant (or where a large Quadrant cannot be managed, a Sextant) and Telescopes are the most useful Instru-

Instruments for both making and satisfying our selves in Discoveries of this Nature, I think will not be doubted. But certainly the best way to use them is in conjunction. Its true there may be several cases in which we respect not much the height or place of a Star; it may be all we design is to view its Colour, Form, Spots, or the like, and then the Telescope it self may suffice. But because Stars appear of different Diameters or sizes, according to their different height or position above the Horizon, therefore we shall be able to make the exactest Observations and truest Judgment, if we have to the side of a large Quadrant (or Sextant) duely fixed a proportionable Telescope joyned and fastned. The way of fixing both it is scarce possible in words so to describe as that it will be plainly understood. But these things may easily be seen, and then most readily understood, if we go to any Artists. And being furnished with such a Machin or Instrument, the best time to use it is not in the lightest Nights, or when the Moon is at Full, (except on some particular occasions) for then the Luminous Raies too much confound one another. It is much best viewing the Moon at or near its Quarters. But if we will see a Full Moon, we must have larger and longer Telescopes than such as can be fixt to Quad-

rants: and there are little Devices to draw the Raies closer by putting a Paper with a Pin-hole in it betwixt our Eye and the Glass, and the like with a little use will easily direct and teach us to contrive.

Then for the Stars, the best time to view any of them is in clear Nights, when there is little or no Moon. A Telescope of six or eight foot will for these, and indeed for the Moon or Sun also, do in a manner as well as one of twenty four or twenty five. The disadvantage of cumbersomness in these large ones is such as scarce countervails the advantages which they have; the chiefest of which is, that they take in a greater part of the Heaven than our lesser Glasses.

But all Persons must be advised how they venture to look on the Sun with Telescopes. For in due position the whole Instrument is but as one violent Burning-Glass, and a Man may easily take such a look in an instant as never to see more with that Eye. Therefore some use to smoak their Glass over a Candle; but the best way is to have a small piece of red or purple Glass to interpose betwixt your Eye and the Glass of the Telescope, and by this means you may view that glorious Body with little or no prejudice. But as to these points, those

who

who ſell theſe Inſtruments will certainly, if deſired, ſhew their Cuſtomers the trueſt and ſafeſt way to uſe them, more plainly than I can ſpeak. I will only here add, that if we deſign a clear ſight of the face or bigneſs of any of the Heavenly Bodies, the worſt time to view any of them is when they are not far from the Horizon; for then the refraction of the Raies is ſo great, that their Bodies appear much larger proportionably than at other times, and in other poſitions, and the ſight of them too is much more confuſed; By which one note, any Perſon may be able to direct himſelf what Stars are in a moſt convenient condition for him to view at any time, when his Curioſity leads him to ſuch Entertainments. And truly theſe are Entertainments ſo noble and glorious, as well as raviſhing and tranſporting, that it is to be wondred how Perſons whoſe Parts and Fortunes qualifie them for them, are able to temperate themſelves from them.

But perhaps it will be ſaid the uncertainty of the truth of them diſcourages. Of that therefore we will conſider in the next place.

SECT. X.

What certainty there may be concluded in these Curiosities and Discoveries.

TO come to a perfect and exact knowledge of the distance of the Heavenly Bodies, (by Miles or such known measures) of their bigness, substance, frame, and contexture is not to be expected: nor will any, except Madmen, pretend to have made such Discoveries. There are very few things which Wise Men will say they thoroughly understand, even amongst these Sublunary Bodies. But there is as great a difference betwixt the knowledge which Artists and Speculative Men have of the Heavens, Stars, and Orbs, and that which the Common People have, as there is betwixt the Common Peoples and Brutes notices of them. To come to particulars.

The Parallax of the Moon is very sensibly discoverable. Its Horizontal Parallax is above a whole Degree. Therefore the distance of the Moon may be more certainly concluded upon, and more firmly credited. In the other Stars I confess the Case is more difficult, and the Work finer, so that

that the Result exceeds not probability. For in *Mercury*, *Venus*, the *Sun*, and *Mars*, we cannot without great difficulty observe any Parallax, and that which we can at length observe is very small. In *Jupiter* and *Saturn* there is scarce any. And as to the fixed Stars they are so vastly above us, that we are to expect none in them. The reason hereof is, that the Semidiameter of the Earth, which is taken in these Cases for the common Measure, and as the interstice between the two supposed Dimensory Stations, bears some sensible proportion to the distance of the Moon; but as to the distance of those other Bodies, its proportion is so very small, as almost to vanish when applied thereto. As if the Earth were but in comparison of them as a Point, and there were no difference whether we behold them from the Surface of the Earth, or from its Center. By which ingenuous dealing the Reader will be able easily to gather what kind of belief he is to give to the foregoing Calculations or Accounts of the distances and Magnitudes of these Bodies. They are mostly but the Conjectures of Men very learned, knowing, and industrious in this kind.

And

And as to those Discoveries mentioned in the first part of this Book, it may perhaps be suspected they are also as uncertain, because of the diversity of Refractions and *Mediums*, the vast distance and other like Points. But it is to be said hereto; Those Objects which constantly through divers Glasses, at divers times, and by divers Spectators observed, still generally, or most commonly appear the same, are certainly as they appear. *Saturn* therefore most surely has such *Ansulæ* of Light as he is represented. *Jupiter* has such Obscurer Tracts as those termed his *Belts* or *Girdle*. *Mars* such Features as I may call them as above described. The *Sun* and *Moon* such *Spots*. And *Venus* her different *Phases*, sometimes as an Half, Quarter, or Full Moon. And there are none of these but are far a more glorious Light than they can be conceived, when seen only in such Figures, as we have been able to represent them in. The seeing them as near as we can by the help of our Glasses, in themselves fills the Fancy with delightful news Idea's; and the Understanding with new curious Contemplations, and prepares and raises the Mind to most Noble, Curious, and Divine Speculations, as well as Wonder and Content. Then as to those *New Stars*, (as I may call them) that

that is, ſuch Stars as we cannot eſpy with our naked Eye, but do plainly ſee, and can count with the help of our Glaſſes; (ſuch as are not only very many little ones, but one larger of the ſeven Stars in the *Pleiades*, that infinite multitude in the *Galaxy* or *Milky Way*, *&c.*) Theſe are moſt certain things, and not meer appearances: becauſe if an hundred People look at them, and have one hundred Teleſcopes, they ſhall all ſee the ſame Stars, and be able to count them, and deſcribe their Poſition, or the Figures they make as they ſtand all along in the Tracts of the Heavens. Theſe therefore can be no ſparklings of Light, or falſe appearances in the Glaſſes, but muſt be real and proper Stars: ſome of them certainly very vaſtly above the others, and having different Centers of motion, or different Orbs from the others. Moſt of theſe things therefore cannot be doubted.

And *de facto*, it is not now doubted, I think, by any who have uſed Teleſcopes in viewing the Heavens, that in the *Firmament*, as it is uſually called, or Sphere of fixed Stars, there are ſeveral Stars which have a peculiar motion of their own, and are as it were Suns too, and illuminate others, as our Sun does the Moon and other Planets.

But

But the Theory of these things would lead us into heights as far beyond our Conception and Comprehension, as above our Sight: We will therefore here sit down a while and wonder, and put a stop to our thoughts of the Stars.

Soli Deo Gloria.